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Spectrum — In Plain Language

By Thomas Kidd - January-March 2014

This article takes terms commonly associated with electromagnetic spectrum and presents them in plain language and within context. These terms are identified in ***bolded italics***.

The full electromagnetic ***spectrum*** covers all manmade and natural electromagnetic waves, including radio, microwave, infrared, visible, ultraviolet, x-rays, gamma-rays. These electromagnetic waves are referenced by their frequency, measured in cycles per second or hertz (Hz). Earth naturally emits an extremely low electromagnetic resonant frequency of about 7.8 Hz. Gamma-ray waves have frequencies as high as 1024 Hz. This article addresses ***radio frequency*** spectrum, which begins below 10 kilohertz (kHz) and extends above 250 gigahertz (GHz).

Radio frequency spectrum is further subdivided into smaller sections called ***frequency bands***. Frequency bands may be just a few hertz wide, such as the 100-Hz-wide band between 19.95 kHz and 20.05 kHz used for standard frequency and time signals; or they may be many billions of hertz (GHz) wide, such as the 217-226 GHz band, which includes radio astronomy frequencies.

Spectrum is a sovereign resource of each nation. Though many nations tend to ***allocate*** their spectrum similarly, there can be subtle or significant differences in how specific frequency bands are allocated because each nation can allocate spectrum as it sees fit for its requirements. Around the globe, radio frequencies are divided into hundreds of frequency bands. Some of these frequency bands are harmonized between countries, but others are not. For example, in the United States, the frequency band 7.2-7.3 megahertz (MHz) is used by amateur radio operators, but that same band is used by radio broadcasters in Europe, Africa and Asia. When the United States military is a guest in a host nation for testing, training, providing humanitarian support, or conducting other operations, it is required to operate its equipment in accordance with the host nation's spectrum allocations and laws.

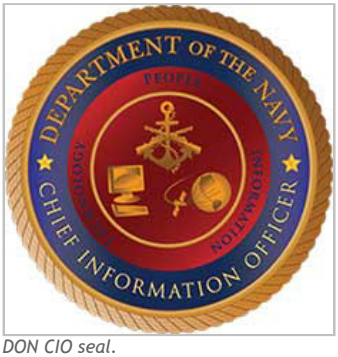
The Department of the Navy (DON) must realize that systems built to operate inside the United States may not have ***host nation coordination*** to operate in other countries. This is a crucial issue, and it is why it is imperative that our warfighters work with their spectrum managers for ***host nation coordination*** before deploying spectrum-dependent systems in another country.

The use allocated to a discrete frequency band is called a ***service***. For example, Maritime Mobile Service Network, Meteorological Aids, Radiolocation and Radio Astronomy are individual services; each identifies how spectrum is authorized to be used in each specific frequency band. Services are established and defined in the International Telecommunication Union's Radio Regulations. A basic method to avoid radio frequency interference is to limit certain services to specific frequency bands. This approach assures that high power radars in the Radiolocation service are not operating in the same frequency band, and overloading extremely sensitive radio telescopes operating in the Radio Astronomy service.

Electromagnetic spectrum is a finite natural resource. There is no more or less spectrum today than there was before the invention of radio transmitters, and new technologies must find space in the existing, crowded electromagnetic environment. In parts of the world, including many areas of the United States with high population density, access to electromagnetic spectrum is exceptionally scarce. To manage these shortages, national and international regulators must occasionally change how electromagnetic spectrum is allocated to specific services within particular frequency bands. This is called ***reallocation***. Reallocation may enable the growth of a new technology, such as next generation mobile broadband, or it may expand the use of an existing service, such as increasing the capabilities of the Aeronautical Mobile Service, involving mobile communications between aircraft and ground stations.

However, reallocation can be very expensive and can take a very long time to execute. For example, some systems, such as satellites, are not designed to be recalled for modifications that would enable reallocation. The only option may be to replace the system with new technology that meets the reallocation requirements. Relocating a device from one place in the spectrum to another has additional challenges.

The new "location" must have enough room to include the new system and must also be



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operationally suitable for the new system, for example, high or low enough in the spectrum for the unique properties and composition of the system to work. Parts of the spectrum have different properties such as electromagnetic waves that can "see" through rain while other waves can bounce off the ionosphere. A system that relies on specific properties cannot relocate into another spectrum area with different properties.

Before spectrum-dependent systems and equipment may be used in many countries, including the United States, their characteristics must be certified by the national spectrum regulators to determine that the device will access spectrum within specified allocations and operate according to other regulations. Within the United States, control of the electromagnetic spectrum is shared between the Federal Communications Commission (FCC) and National Telecommunications and Information Administration (NTIA). All manufacturers are required to obtain FCC ***certification*** before selling spectrum-dependent devices to the public. All federal government agencies are required to obtain NTIA ***certification*** before they buy spectrum-dependent devices.

Certification can take a short time or several years depending on the complexity of the system, the current allocation of the spectrum, and the intended use of the device. Therefore, DON acquisition programs are encouraged to seek spectrum management advice as early in their spectrum-dependent system's development as practical. At a very minimum, spectrum certification must be completed prior to a Milestone C decision, which initiates the production and deployment phase.

The NTIA assigns federal agencies, including the DON, the authorization to use a specific frequency at a specific spectrum location for a specific purpose and use. This ***assignment*** is a federal agency's license to operate. Assignment details include parameters such as power, antenna height, radius for mobile operations, and the use of the frequency.

The NTIA regulates all ***federal users*** who are part of the executive branch of the government. These users include: the National Science Foundation; National Aeronautical and Space Administration; Federal Aviation Administration; the military departments of the Army, Navy and Air Force; and other federal agencies such as the departments of Interior, Agriculture and Justice.

The FCC regulates all state and local government, commercial business and private citizen use of spectrum. In regulations, these users are referred to as ***non-federal users***. There are a few exclusive portions of spectrum designated as ***non-federal***, which includes the 88-108 MHz band for FM radio broadcasting. There are also a few federal exclusive bands, such as 14.5-14.8 GHz, used for space research. In general, though, nearly all electromagnetic spectrum is shared between federal and non-federal users.

Access to the electromagnetic spectrum is critical to effective Navy and Marine Corps operations. Working closely with the Assistant Secretary of the Navy for Research, Development and Acquisition, the DON Deputy Chief Information Officers for the Navy and the Marine Corps, and dedicated spectrum management professionals, the DON CIO engages in national and international forums to increase spectrum-dependent system efficiency, flexibility and adaptability and to assure optimum use of this valuable resource.

Tom Kidd is the strategic spectrum policy lead for the DON Chief Information Officer. He was named "Agency Vice Chairman" of the Interdepartment Radio Advisory Committee (IRAC) April 23, 2013.

TAGS: Cybersecurity, Governance, Spectrum, Telecommunications, Wireless

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